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INTRODUCTION

Jan Harmsen
State University Groningen, Groningen, The Netherlands

1.1 REASON FOR THIS BOOK

The editors of this book have long industrial experience in process development and novel commercial-scale process implementations. In the past decade we became convinced that sustainable development (SD) is a good driver for innovation, as it makes good business sense to provide for the needs of people in an ecological, economical, and socially acceptable way. Our company, Shell, was adopted sustainable development as one of its business principles, as have many other companies. Formation of the World Business Council for Sustainable Development, with its large number of contributing companies worldwide, is a good indicator of this new direction in global businesses.

However, we felt the lack of reported industrial cases necessary to convince and inspire our colleagues, academics, and students that, indeed, sustainable development has entered the process industry. We assumed that industrial cases existed not only in our company but were also present in other companies. Evidence for this was obtained from the overwhelming response to a proposed session of the American Institute of Chemical Engineers in the spring of 2006 in Orlando, Florida, on "Sustainability in Practice," which ultimately swelled into a four-session topical conference. So when we asked our peers in the process industry to provide written cases from their companies to serve as chapters in this book, they responded quickly. All of them had to

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write the cases at least partially in their spare time, but they were sufficiently motivated to do so. Obtaining permission to publish the case descriptions presented another hurdle, but that hurdle was also overcome. So what you find in this book are true industrial cases of novel processes or systems that contribute to sustainable development based on the "triple bottom line" or "triple P" dimensions of "people, planet, and profits."[1]

1.2 SCOPE OF THE BOOK

To make the book as useful as possible, we obtained cases from a variety of:

- *Industries:* oil and gas, bulk chemical, specialty chemical, material and mineral processing
- *Global regions:* Asia, Europe, and the United States
- *Systems:* industrial ecopark, regional development, domestic-industrial ecology, individual corporate operating sites

To the example cases we added methods and metrics that can be used by industry to assess processes as to sustainability. All examples are real industrial cases. Some of the processes are in the pilot-plant stage, but most have already been implemented at a commercial-scale capacity.

1.3 USE IN EDUCATION

The book can be used in many different academic educational programs and courses and in many different ways. Perhaps the first use is to motivate students to work on sustainable development, because it is a real business driver, as shown in the industrial cases. In undergraduate courses, the book can be used to provide students with real examples of industrial sustainable systems and processes. Chapters 12 and 14 illustrate the concept of industrial ecology with the closing of material cycles. A very simple and clear case on domestic wastewater used as feed for boiler feedwater production is described in Chapter 14. A further example, on by-product synergy, is provided in Chapter 6. Also, the translation of the high-level "triple P" dimensions into qualitative and quantitative methods and metrics to assess real processes and their life cycles are illustrated in the cases. In graduate-level courses, the book can be used as test cases and scenarios for the evaluation of theories and frameworks for sustainable development.

[1]The origins of "triple P" (or "3P"), encompassing "people, planet, and profits," and "triple bottom line," denoted as "TBL" or "3BL," are described in the preface and are attributed to John Elkington in publications such as *Cannibals with Forks: The Triple Bottom Line of 21st Century Business* (Oxford, UK: Capstone, 1997).

The benefit of incorporating all three dimensions of sustainable development (ecology, economy, and society) in solutions is highlighted by the examples provided in Chapters 3 to 6. For industrial ecology courses, Chapters 4 to 6 and 14 will be useful. The cases presented can be used to illustrate the practical use of the corresponding principles.

Courses on renewable energy can benefit from Chapters 7 to 9. Courses on process design can benefit from any of the industrial cases. In particular, the closing of material cycles is illustrated in Chapter 12, a case study from an anodizing company.

Courses on life-cycle assessment can use Chapter 8, based on an integrated biorefinery, and Chapter 14, a case on industrial symbiosis in wastewater management, where an end-of-cycle wastewater stream is upgraded to a feedstock for chemical processes. Cases throughout the book can be used to analyze the various emission types and emission reductions obtained by the synergy between a local society's waste and the use of that waste by a company, compared to the choice of a conventional solution.

1.4 USE IN INDUSTRY

The book can be used by anyone in industry to convince others in a company that working on innovative processes and systems that contribute to sustainable development makes good business sense and to demonstrate that many other companies are already doing it. An excellent treatment of value added is presented in Chapter 6 using such an innovative process. The book can also be used to apply sustainable development metrics to rank existing and novel process alternatives for sustainability, and to give direction and guidance to process innovation, and small and medium-sized enterprise companies can use the very practical strategy provided to implement sustainable development in their companies. In addition, the book can be used to obtain specific ideas and insights on how to modify processes to direct them toward more sustainable deployment of technology within an industry.